

Endrin Food-Poisoning

A Report on Four Outbreaks Caused by Two Separate Shipments of Endrin-contaminated Flour

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Between 3 June and 15 July 1967 four explosive outbreaks of acute poisoning with the insecticide endrin occurred in Doha in Qatar and Hofuf in Saudi Arabia. Altogether 874 persons were hospitalized and 26 died. It is estimated that many others were poisoned whose symptoms were not so severe as to cause them to seek medical care or to enter hospital.

The author describes the course of the outbreaks and the measures taken to ascertain their cause and prevent their extension and recurrence. It was found that the victims had eaten bread made from flour contaminated with endrin. In two different ships, both of them loaded and off-loaded at different ports, flour and endrin had been stowed in the same hold, with the endrin above the flour. In both ships the endrin containers had leaked and penetrated the sacks of flour which was later used to make bread.

These two unconnected but nearly simultaneous mass poisonings emphasize the importance of regulating the carriage of insecticides and other toxic chemicals in such a way as to prevent the contamination of foodstuffs and similar substances during transport; both the World Health Organization and the Inter-Governmental Maritime Consultative Organization are working towards the establishment of regulations and practices to that end.

INTRODUCTION

This report represents the compilation of information provided by many individuals from different organizations in several different countries. It was only with their fullest co-operation and understanding that this report was made possible and full acknowledgement and appreciation is extended to them. A list of these individuals and organizations is given in the Annex.

The purpose of this compilation is to inform and to alert health organizations, private industry, governments and the appropriate international regulating agencies to the very real threat to the health and lives of individuals that is caused by the current methods of shipment of foodstuffs and toxic chemicals. Episodes such as those described in this report, which are preventable, can be expected to

occur again unless changes are made in packaging, handling and stowage of these materials.²

Between 3 June and 15 July 1967, there were four explosive outbreaks of acute endrin³ intoxication in the cities of Doha in Qatar and Hofuf in Saudi Arabia. In total 874 persons were hospitalized and there were 26 deaths. It was estimated that another 500 to 750 persons were poisoned in these outbreaks but their symptoms were not severe enough to cause them to seek medical care or to be hospitalized.

The victims had ingested the endrin by consuming bread made from endrin-contaminated flour. This

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² Since the preparation of this report two further serious outbreaks of poisoning have been reported involving the contamination of foodstuffs by insecticides during transportation. In Mexico, 15 persons died and 100 more were made ill after consuming bread made from flour contaminated by parathion during transportation. In Colombia 165 persons were hospitalized, of whom 63 died, after eating bread made from flour which became contaminated with parathion during carriage in a truck.

³ Endrin is 1,2,3,4,10,10-hexachloro-6,7 epoxy-1,4,4a,6,7,8,8a-octahydro-1-4-endo-endo-5-8-dimethanonaphthalene, an insecticide used in agriculture against soil and foliage insects.

flour came from two different locations in the USA on board two different ships and was off-loaded at two different ports, one in Qatar and the other in Saudi Arabia. However, both ships carried endrin which had been stowed above the flour. The containers of endrin from both ships were reportedly leaking when off-loaded in Khorramshahr, Iran.

Outbreaks of insecticide poisoning caused by contamination of foodstuffs during shipment have been reported previously (see Table 1). One of the earliest also incriminated endrin-contaminated flour. This occurred in Wales (Davies & Lewis, 1956). The outbreak did not result in any deaths but did cause severe illness in 59 persons. Endrin had been spilled on the floor of a railway car which was later used to transport sacks of flour; these picked up sufficient amounts of endrin from the floor of the car to produce illness in persons who consumed bread made from the contaminated flour.

In Kerala, India, Karunakaran (1958) reported 106 deaths and 828 persons ill in an outbreak of parathion poisoning which occurred following contamination of foodstuffs. The foodstuffs, including flour and sugar, were contaminated from leaking containers of parathion stowed during shipment in the same hold as the foodstuffs.

An outbreak of parathion poisoning was reported from Singapore (Kanagarathnam et al., 1960) in which 38 persons were made ill and 9 died. Barley was the vehicle for the parathion. The specific means of contamination were not defined, but contamination of the barley in the country from which it was shipped and contamination after leaving the importers' warehouse were excluded as possibilities when the outbreak was investigated. Contamination during shipment was not reported to have been conclusively ruled out.

In the United Arab Republic another incident involving endrin-contaminated bread was reported to have caused acute poisoning in 3 people (Coble et al., 1967). In this limited outbreak the specific manner in which the flour was contaminated was not ascertained but it was assumed that it occurred in transport or during storage.

Materials other than foodstuffs have been significantly contaminated by insecticides during shipment. Warren et al. (1963) reported illness in 6 children following phosdrin contamination of boys' trousers (blue jeans). This contamination occurred when the trousers and phosdrin were shipped in the same truck. Anderson et al. (1965) reported severe illness in 2 boys as a result of acute parathion intoxication.

TABLE 1
SUMMARY OF PREVIOUSLY REPORTED INCIDENTS OF ACUTE INSECTICIDE INTOXICATION
FOLLOWING CONTAMINATION OF MATERIAL DURING STORAGE OR SHIPMENT

Place and year	Insecticide	Material contaminated	Number ill	Number dead	Mechanism of contamination
Wales, 1956 ^a	Endrin	Flour	59	0	Absorption of spilled endrin by sacks of flour from floor of railway car.
Kerala, India, 1958 ^b	Parathion	Flour, sugar and other foodstuffs	828	106	Foodstuffs contaminated by leaking containers of parathion stowed in the same hold as the foodstuffs.
Singapore, 1960 ^c	Parathion	Barley	38	9	Not known; contamination during shipment not conclusively ruled out.
California, USA 1963 ^d	Phosdrin	Boys' trousers	6	0	Contamination took place during shipment of trousers and phosdrin in the same truck.
Canada ^e	Parathion	Flannelette sheets	2	0	Sheets and parathion were stowed in the same hold and contamination took place during shipment.
UAR, 1967 ^f	Endrin	Flour	3	0	Contamination was assumed to have occurred during transport or stowage of the flour.

^a Davies & Lewis (1956).

^b Karunakaran (1958).

^c Kanagarathnam et al. (1960).

^d Warren et al. (1963).

^e Anderson et al. (1965).

^f Coble et al. (1967).

The victims acquired the parathion through contact with parathion-contaminated flannelette sheets, which had been stowed in the same hold as parathion during shipment to Canada.

THE DOHA, QATAR, OUTBREAKS

First outbreak

Doha is the capital city of Qatar and has an estimated population of 40 000 to 50 000 persons. A significant portion of the population consists of expatriates from other Middle Eastern countries.

There had been no unusual incidence of illness in Doha until the morning of 3 June 1967. At 7.45 a.m. an 11-year-old boy was admitted to the Doha Government Hospital because he had suddenly fallen unconscious. Spasms of the facial muscles were observed, followed by a grand mal convulsion. This admission was the first of over 300 patients who inundated the Government Hospital in the following 4 hours. The patients presented with a variety of signs and symptoms that included abdominal pain, nausea, vomiting, lethargy, mental confusion, unconsciousness and convulsions (Table 2). The peak of admissions occurred at about 11.00 a.m., then gradually slackened off, only to be followed by a second but smaller peak at about 3.30 p.m. By evening and

during the next two days the number of persons with this symptom complex admitted to hospital rapidly decreased. In total, 490 persons were admitted and there were 7 deaths.

The severity of the illness in such a large number of persons in such a short period of time made it imperative that the hospital staff direct their entire attention to the care of the victims. As a result, the usual hospital medical records were not maintained and were thus not available for detailed analysis after the outbreak. Two days later, 110 of the victims were questioned further and the epidemiological data that were derived from these interviews are presented in Tables 3, 4 and 5.

The local physicians believed that the illness was acute organophosphate poisoning and began treatment with phenobarbital, atropine and chlorpromazine. Some of the initial patients were also treated with pralidoxime iodide but the local supply was soon exhausted.

A visiting internal medicine consultant carried out a careful clinical examination of 10 adult victims recently admitted to hospital. He reported to have found that the pupils were reactive, equal and with normal diameter in those patients. He observed no muscle fasciculation or fibrillation and no pulmonary oedema. At the time of the examination blood was obtained and sent directly to a laboratory in Dhahran,

TABLE 2
MOST COMMON SYMPTOMS GIVEN BY THE VICTIMS
OF 2 OF THE 4 OUTBREAKS

Symptom	Percentage with indicated symptoms	
	First Doha outbreak ^a (n = 110)	Hofuf outbreak ^b (n = 54)
Vomiting	69	83
Convulsions	65	67
Abdominal discomfort	48	19
Nausea and dizziness	38	28
Headache	60	2
Sudden loss of consciousness	5	4

^a These data were obtained by an epidemiological team from ARAMCO. The selection of the 110 victims was not randomized but represents those persons still in hospital on 4 June and thus presumably the more severely ill as the majority of those hospitalized were discharged 5 to 12 hours after admission. Also included were some of the patients admitted on 4 or 5 June.

^b The 54 interviews in Hofuf were conducted on 15 July by the same epidemiological team as obtained the information in the first Doha outbreak.

TABLE 3
AGE DISTRIBUTION OF HOSPITALIZED VICTIMS IN 2 OF
THE 4 OUTBREAKS

Age-group (years)	Percentage in each age-group	
	First Doha outbreak ^a (n = 110)	Hofuf outbreak ^b (n = 54)
1-9	13	15
10-19	11	11
20-29	30	29
30-39	27	20
40-49	9	4
≥ 50	9	20

^a These data were obtained by an epidemiological team from ARAMCO. The selection of the 110 victims was not randomized but represents those persons still in hospital on 4 June and thus presumably the more severely ill as the majority of those hospitalized were discharged 5 to 12 hours after admission. Also included were some of the patients admitted on 4 or 5 June.

^b The 54 interviews in Hofuf were conducted on 15 July by the same epidemiological team as obtained the information in the first Doha outbreak.

TABLE 4
SEX DISTRIBUTION OF HOSPITALIZED VICTIMS
IN 3 OF THE 4 OUTBREAKS ^a

Sex	Percentage of each sex		
	First Doha outbreak ^b (n = 110)	Third Doha outbreak ^c (n = 169)	Hofuf outbreak ^d (n = 54)
Male	63	68	69
Female	37	32	31

^a Data on the second Doha outbreak were not obtained.

^b These data were obtained by an epidemiological team from ARAMCO. The selection of the 110 victims was not randomized but represents those persons still in hospital on 4 June and thus presumably the more severely ill as the majority of those hospitalized were discharged 5 to 12 hours after admission. Also included were some of the patients admitted on 4 or 5 June.

^c These data were obtained by the local health authorities shortly after admission of the victims to hospital.

^d The 54 interviews in Hofuf were conducted on 15 July by the same epidemiological team as obtained the information in the first Doha outbreak.

TABLE 5
ORIGIN OF VICTIMS IN 2 OF THE DOHA OUTBREAKS

	Percentage of indicated origin	
	First Doha outbreak ^a (n = 110)	Third Doha outbreak ^b (n = 169)
Qataris	30	57
Non-Qataris	70	43

^a These data were obtained by an epidemiological team from ARAMCO. The selection of the 110 victims was not randomized but represents those persons still in hospital on 4 June and thus presumably the more severely ill as the majority of those hospitalized were discharged 5 to 12 hours after admission. Also included were some of the patients admitted on 4 or 5 June.

^b These data were obtained by the local health authorities shortly after admission of the victims to hospital.

Saudi Arabia. Using the Unopette test (Gerarde et al., 1965), the laboratory found normal cholinesterase activity in the 10 blood specimens.

Many of the victims improved rapidly in the 2nd to 5th hour after admission and were discharged from hospital. Preliminary epidemiological information was obtained from them and from members of their families. Initially, because of the large number of cases and the scattered distribution of their dwellings throughout the city, water was thought to be the vehicle for the then suspected organophosphate. The public was told to stop drinking water

and an intensive investigation of the water supply and distribution system was conducted. In fact, over the next few days there were repeated inspections of the water system (conducted by the local health authorities in conjunction with persons from the World Health Organization and the Arabian American Oil Company). Repeated bacteriological and chemical analysis of the water failed to demonstrate any abnormality that could be related to the outbreak. Forced feeding of the water to mice failed to produce illness. No positive relationship could be shown between the source of drinking-water or the history of consuming water and the illness.

The victims stated that they were in good health until 1 to 2 hours after having eaten their morning meal (Table 6). A rapid survey of a small sample

TABLE 6
TIME BETWEEN INGESTION OF MEAL AND
ONSET OF SYMPTOMS ^a

Time (hours)	Percentage of interviewed victims (n = 156)
<1	12
1	34
2	26
3	10
4	5
5-10	13

^a Based on 102 interviews of victims of first Doha outbreak and 54 interviews of victims of the Hofuf outbreak.

of cases revealed that the most common food consumed for breakfast was bread (Table 7), and that invariably the bread was from a single bakery, one of approximately 60 bakeries in Doha. Later, a survey of 110 of the victims confirmed this information. There were 7 deaths in this outbreak, all occurring within 12 hours of the onset of symptoms. The age and sex of the victims are shown in Tables 8 and 9.

Subsequent investigation revealed that the owner of this bakery and 3 of his employees were among the earliest victims of the outbreak. In contrast, none of the other bakery owners or their employees reported ill during this outbreak.

The bakery which was thought to be the source of the suspected bread produced about 6000 to 7000 pieces daily of what is locally called "Lebanese"

TABLE 7
FOOD ITEMS IN THE MEAL CONSUMED BY VICTIMS PRIOR TO ONSET OF SYMPTOMS ^a

Food item ^b	Percentage consuming indicated item			
	First Doha outbreak ^b (n = 181) (Breakfast)	Second Doha outbreak ^c (n = 13) (Dinner)	Third Doha outbreak ^c (n = 169) (Dinner)	Hofuf outbreak ^d (n = 54) (Dinner)
Bread	88	100	80	89
Water	69	INA	35	61
Salona (stew)	0	INA	21	52
Tea	17	INA	10	24
Vegetables and fruit	1	INA	16	6
Rice	4	INA	11	6
Milk	0	INA	0	24
Others	5	INA	8	3

^a INA = information not available.

^b These data were obtained by an epidemiological team from ARAMCO. The selection of the 110 victims was not randomized but represents those persons still in hospital on 4 June and thus presumably the more severely ill as the majority of those hospitalized were discharged 5 to 12 hours after admission. Also included were some of the patients admitted on 4 or 5 June.

^c These data were obtained by the local health authorities.

^d The 54 interviews in Hofuf were conducted on 15 July by the same epidemiological team as obtained the information in the first Doha outbreak.

bread. Each piece is a flat, thin, circular patty about 12 inches (30 cm) in diameter and weighs about 120 g–140 g. In this bakery a sufficient amount of dough is prepared to make about 500 pieces at one time by mixing three types of flour, sugar, salt, yeast and water together in a mechanical mixer. The dough is covered with a nylon cloth for approximately 15 to 30 minutes to permit it to rise. When the dough is ready, small pieces are cut, rolled into circular shapes, placed on large trays and then transferred by hand on to a wooden paddle which in turn is used to place the dough in the oven. The bread is sold shortly after baking. Only a small amount is sold at the bakery itself. Most of it is distributed by a small panel truck and bicycles throughout Doha to private homes, hotels and restaurants.

The bakery was found to have the average level of sanitation for bakeries of the area. Six different brands of sacked flour were found in the bakery, all of them imported. It was also reported that the baker had often used a benzene hexachloride insecticide for insect control and to "poison rats and mice" in the bakery.

Trained technicians carefully took specimens of flour, bread crusts from around the oven, dough

from the mixing bowl and flour from the work-bench. These specimens, with blood and urine specimens from 10 acute patients, and stomach, liver and kidney specimens obtained from a partial post mortem examination in a fatal case, were sent to the laboratory of the Arabian American Oil Company (ARAMCO) in Dhahran, Saudi Arabia. Using the benzene-soluble-chlorine method they were able to demonstrate up to 220 ppm organic bound chlorine (equivalent to 380 ppm endrin) in the dough and bread from the suspected bakery. Subsamples of the specimens were sent to other laboratories for the identification of the specific chlorinated hydrocarbon.

The working hypothesis of the investigations at this point was that local contamination by benzene hexachloride of the dough, bread or both had occurred in a single bakery in Doha. The result was an explosive outbreak of acute intoxication due to a chlorinated hydrocarbon. The victims' histories, the clinical picture and the epidemiological pattern were fully compatible with this explanation. The laboratory findings supported this view but did not confirm it.

As a precautionary measure, all the bakeries in Doha were closed on 3 June. Each bakery was to be

TABLE 8
DEATHS IN THE 4 OUTBREAKS, BY SEX ^a

Sex	Number of deaths					Percentage of total deaths
	First Doha outbreak	Second Doha outbreak	Third Doha outbreak	Hofuf outbreak	Total deaths	
Male	5	0	11	1	17	65
Female	2	0	6	1	9	35
Total	7	0	17	2	26	

^a These data were provided by the local health authorities in Doha and Hofuf.

TABLE 9
DEATHS IN THE 4 OUTBREAKS, BY AGE ^a

Age-group (years)	Number of deaths					Percentage of total deaths
	First Doha outbreak	Second Doha outbreak	Third Doha outbreak	Hofuf outbreak	Total deaths	
1-9	3	0	6	1	10	38.5
10-19	0	0	2	0	2	7.7
20-29	0	0	3	0	3	11.5
30-39	2	0	4	0	6	23.0
40-49	0	0	1	0	1	3.8
≥50	2	0	1	1	4	15.4
Total	7	0	17	2	26	

^a These data were provided by the local health authorities in Doha and Hofuf.

inspected to ensure that there were no insecticides on the premises, and within the next few weeks the bakeries were again in operation.

Second outbreak

On the evening of 2 July, a family of 13 persons went to the Doha Government Hospital with the same signs and symptoms as had been observed in the victims of the first outbreak. They also gave a history of having eaten bread an hour preceding the onset of the illness. None of the victims of the outbreak died. The family owned the bakery (a different bakery from the one involved in the first outbreak) which had prepared the suspected bread. That day they had baked only enough bread for their own needs and none had been sold. This bread is locally described as "Iranian" bread and is

similar to the "Lebanese" bread but weighs only 80 g and is baked by a different method. The bakery prepares only enough dough for 30 to 50 pieces. When it is ready for baking small patties of dough are slapped by hand against the hot interior of a large earthen bowl about 5 feet (1.5 m) tall and 4 feet (1.2 m) wide which is heated by a fire at its base. They are removed by a long wire hook when the baking is completed. Usually no more than 8 to 10 pieces can be baked at one time. This kind of bread is reported to be more popular among the indigenous population than it is among the expatriates in Qatar. This may be reflected in the different pattern in which Qataris and non-Qataris were involved in the separate outbreaks in Doha (see Table 5).

Inspection of the bakery revealed nothing that was unusual. One of the brands of flour was the

same as had been used in the first bakery. No insecticide was found in this bakery.

Third outbreak

The Doha Government Hospital was again flooded with patients on the evening of 3 July, one month after the first outbreak. The clinical picture was a repetition of the first two outbreaks. Again the story of having eaten bread prior to the onset of symptoms was elicited. This time a third bakery was implicated. In a few hours 188 patients were admitted to hospital; 17 subsequently died.

Again a single bakery was readily linked with this outbreak. This bakery also produced "Iranian" bread, as described in the second Doha outbreak. Inspection of the bakery failed to uncover any information which might have explained the cause of the poisoning. Specimens of flour and bread from this bakery and stomach-tissue specimens of one of the victims which were obtained at a post mortem examination were immediately despatched to laboratories in the USA and England.

It was obvious that three separate local contaminations in each of the three different bakeries was an exceedingly unlikely possibility. The bakeries were located in different parts of the city, they were owned and operated by different persons and one of them prepared the bread differently from the

other two. The only common factor that could be established between the three bakeries was that each had used the same brand of flour in the preparation of the bread that had caused the illness. Investigation revealed that this flour, in cloth sacks pervious to liquids, had been shipped as two consignments, totalling 3000 sacks, in the same hold of a freighter from Houston, Texas, on 24 March 1967. This freighter, designated in this report as Ship A, arrived at Um Said, the port of the city of Doha, on 22 May 1967.

At the time this new information was becoming known, the Doha health authorities were informed by the World Health Organization that the Toxicological Laboratories, National Communicable Disease Center, Atlanta, Ga., USA, had found endrin in some of the specimens of flour and bread, and that the levels of endrin in the blood specimens were indicative of acute endrin intoxication (see Table 10).

The Shell Research Laboratory, Sittingbourne, Kent, England, had sent laboratory personnel to Doha. They assisted in the investigation and carried out analyses for endrin in the field using the thin-layer chromatography technique. Later they were able to demonstrate levels of endrin contamination similar to those given in Table 10. Two detectives from New Scotland Yard also participated in the investigations at this time at the request of the Government of Qatar.

TABLE 10
ENDRIN CONCENTRATIONS FOUND IN VARIOUS SAMPLES
FROM 3 OF THE 4 OUTBREAKS ^a

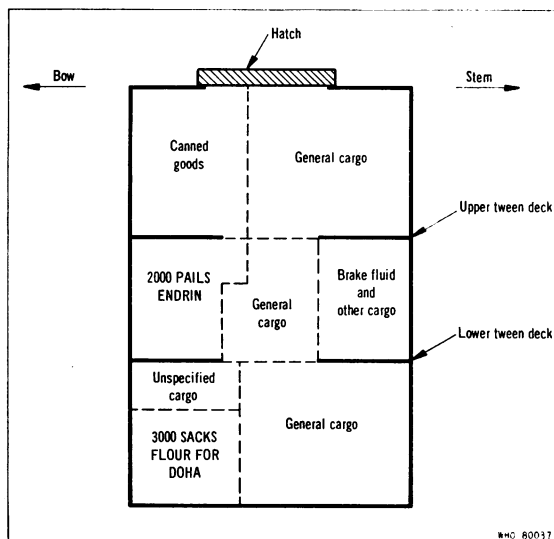
Sample	Endrin concentration (ppm)		
	First Doha outbreak	Third Doha outbreak	Hofuf outbreak
Bread, portions of which had been eaten by patients	48	1 339-1 807	243-537
Flour, used to make the same bread	INA	2 153	3 367
Blood from patients	0.007-0.032	INA	0.008-0.027
Urine from patients	INA	INA	<0.004-0.007
Vomitus from patients	INA	INA	5.24
Tissues (autopsy) from:			
stomach wall	0.16		
liver	0.685	INA	INA
kidney	0.116		

^a These laboratory analyses were carried out by gas-liquid chromatography in the Toxicological Laboratories, National Communicable Disease Center, Atlanta, Ga., USA. INA = information not available.

Many different insecticides are used in Qatar, but a thorough search of wholesale and retail outlets for insecticides failed to uncover any endrin in Doha. It was later learned that endrin had never been used in Qatar.

FIG. 1

DIAGRAMMATIC SKETCH OF LONGITUDINAL SECTION OF HOLD 1 IN SHIP A, INDICATING MAIN CONTENTS^a



^a Flour from these 3000 sacks was implicated in the 3 Doha outbreaks.

The cargo-stowage plans of Ship A indicated that the flour had been stowed in the lower deck, and immediately above it in the lower tween deck of that same hold had been stowed 2000 5-US-gallon (ca 19-litre) pails of 19.5% emulsifiable concentrate of endrin (Fig. 1). This endrin had been loaded in New Orleans, La., on 18 March 1967 and had been off-loaded at Khorramshahr, Iran, between 14 May and 20 May 1967. At the time of off-loading the endrin, it was noted that 17 of the pails were leaking and 2 were empty.

THE HOFUF, SAUDI ARABIA, OUTBREAK

The city of Hofuf is the major city of the al-Hasa oasis in the Eastern Province of Saudi Arabia. It has a population of about 60 000 persons, with numerous small villages located close by in the surrounding oasis.

On the evening of 14 July 1967 the Hofuf Government Hospital was deluged with patients with iden-

tical symptoms to those that had been observed in the previous outbreaks in Doha (Table 2). In the next 12 hours, 143 persons were admitted to hospital and by the end of the outbreak the total was 183; 2 died (Tables 8 and 9). Again detailed medical records were forgone in order to provide emergency treatment of the severely ill. However, 54 patients were questioned the following day about their illness, and the findings are given in Tables 2, 3 and 4.

The health authorities in the area had previously been informed about the findings in the Doha outbreaks. Indeed, many of the key persons who assisted in the Doha investigations participated in the investigation in Hofuf.

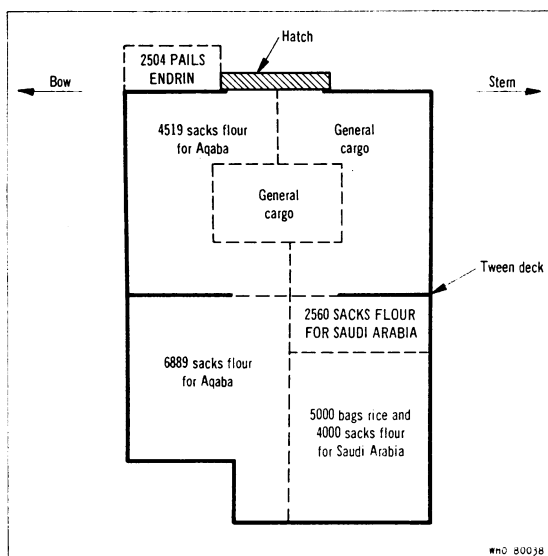
By noon of 15 July, the bakery in which the majority of the victims had purchased the suspected bread had been identified. This bakery produced only the "Iranian" type of bread described in the account of the second Doha outbreak. On inspection, it was found that 10 new sacks of flour had recently been delivered to the bakery and that two-thirds of the contents remained in one of the sacks which had been used to prepare the bread the night before. This flour, with a different brand name from that incriminated in Doha but bagged by the same company in the USA as had bagged the latter, had been purchased from a flour distributor in Hofuf. On inspection of this flour-distributor's warehouse, it was learned that the 10 bags of flour were part of a 4000-bag consignment that had arrived by freighter (designated as Ship B) in the port city of Dammam on 27 June 1967, and were then transported by truck to the warehouse in Hofuf.

All bakeries were closed and the suspected flour was impounded by the authorities. The local water distribution system was also shut down, but was reopened when careful inspection of it failed to show any relationship between water and the outbreak.

The suspected flour had been loaded on Ship B in New Orleans, La., on 26 April and the cargo storage plans and manifest sheet indicated that 2000 sacks of it had been stowed with 560 sacks from a second consignment of 1000 sacks for Saudi Arabia in the lower portion of hold No. 5 (Fig. 2). The remainder was placed in hold No. 1. At a later date, it was learned that the material identified as "white label" on the cargo plans located on the deck over hold No. 5—the same hold as that which contained the suspected flour—was in fact 2504 pails of 19.5% endrin. This endrin had been loaded in New York

FIG. 2

DIAGRAMMATIC SKETCH OF LONGITUDINAL SECTION OF HOLD 5 IN SHIP B, INDICATING MAIN CONTENTS ^a



^a Flour from the load of 2560 sacks was implicated in the Hofuf outbreak. A further 2440 sacks of the consignments for Saudi Arabia were carried in hold 1 of the same ship.

in May and off-loaded in Khorramshahr, Iran, on 24 June. It was reported that some of the containers of endrin were leaking when off-loaded in Iran.

The sacks of incriminated flour in Doha had appeared to be normal, but several of the implicated flour sacks in Hofuf were stained. The red printed labels on some of the cloth sacks were blurred as if they had been splashed with a liquid which had caused the dye of the labels to run. When one of the sacks was carefully opened, the flour directly beneath the label was found to have a red tinge to a depth of about $\frac{1}{2}$ inch (about 13 mm), indicating that the liquid splashed on the surface of the sack had penetrated the sack and had soaked into the flour. Specimens of this sack material, of the red-tinged flour and of flour from deep in the interior of the bag were carefully collected and sent for analysis (see Table 11). Flour from this sack was fed to a healthy cat which died 2 hours later. It was also noted that the stained sacks had a peculiar medicinal odour, and this odour could often be localized to one or two parts of a single sack.

Bread, flour, blood and urine specimens were collected and despatched to laboratories in England and the USA; the results from the latter are shown in Table 10.

TABLE 11

CONCENTRATION OF ENDRIN IN THE SACK MATERIAL AND FLOUR FROM HOFUF OUTBREAK THAT APPEARED TO BE HEAVILY CONTAMINATED ^a

Material analysed	Endrin concentration (ppm)
Sack cloth from stained area	194 000
Flour directly beneath stained area	28 070
Flour from deep inside the sack	4 460

^a These laboratory analyses were carried out by gas-liquid chromatography in the Toxicological Laboratories, National Communicable Disease Center, Atlanta, Ga., USA.

Investigations, as in Qatar, revealed that endrin had not been used or imported into the Eastern Province of Saudi Arabia.

Secondary contamination of other flour in a warehouse

Sacks of flour were examined which had not been on Ship A or Ship B and had not been used to make the incriminated bread, but had been stored in the same warehouse as the contaminated flour. In several of these sacks endrin was also found, but in much lower concentrations than were found in the flour which caused the poisoning. In one of these sacks, the sack material contained 16.2 ppm endrin and the flour in the sack had 9 ppm endrin.

Flour from the floor of the Hofuf warehouse was shown to contain 35.5 ppm endrin.

PRECAUTIONARY MEASURES ADOPTED BY LOCAL AUTHORITIES

Qatar

All the remaining flour that had been brought to Doha on Ship A was impounded and is reported to have been incinerated. Arrangements were made for flour which might have been secondarily contaminated by storage with the heavily contaminated flour to be collected and stored separately. Twenty sacks of this flour were then sampled at a time by going over the surface of the sacks with a vacuum cleaner. This pooled sample was then analysed by thin-layer chromatography, which can detect endrin to a concentration of about 1.0 ppm; if the result of the analysis of the pooled sample was positive all the 20 sacks of flour from which it was taken were to be destroyed. If the results were doubtful, arrangements were made to have the specimen

despatched to a laboratory in England for analysis by gas-liquid chromatography.

To prevent this kind of catastrophe from occurring again, all ships bringing foodstuffs to Qatar are now to be inspected before delivery of the food is accepted. This inspection requires that the captain provide a list of any dangerous goods carried on board the ship. The cargo manifest and stowage diagrams are to be examined to determine the presence and location of toxic chemicals on the ship. The ship is then to be inspected by a sanitary inspector to verify the identity of the cargo and to detect any contamination of foodstuffs that may have occurred.

Foodstuffs accepted for delivery are to be brought from the ship to shore in one of three barges that have been painted white and designated for food only.

Saudi Arabia

All the flour that was brought to Saudi Arabia on board the ship which carried the contaminated flour was impounded, as well as the flour which was in the warehouse with the contaminated flour.

Inspection of ships and their cargo, as is now done in Qatar, is being carried out in Saudi Arabian ports.

DISCUSSION

A total of 874 poison victims were hospitalized in the four outbreaks (Table 12) but the total number of persons made ill by these poisonings is not known. The number of moderately ill persons who did not seek medical care was not determined, although it is estimated at 500-750. Also towards the end of each outbreak, persons who thought they were poisoned reported to hospital with bizarre

symptoms but the possibility of their contact with the poison was excluded and the symptoms were thought to be due to a mild hysterical reaction.

The clinical picture presented by the victims in the four outbreaks is fully compatible with acute chlorinated hydrocarbon intoxication (Hayes, 1963). The rapidity of the onset of signs and symptoms, predominantly of central nervous system stimulation, and the rapid return to normal among those who survived all point towards acute chlorinated hydrocarbon intoxication. Table 2 summarizes the symptoms reported by 164 of the hospitalized victims in Doha and Hofuf. The variations in symptoms reported is probably the result of the technique of acquiring the information. For example, in the first Doha outbreak the patients were specifically questioned about headache and 60% responded in the affirmative, but in the Hofuf outbreak victims were not directly asked if headache was a symptom and only 2% volunteered it as a complaint.

That the intoxication of the victims was due to endrin is borne out by the laboratory analysis of the blood and tissue specimens obtained from the first Doha outbreak and of the blood specimens from the Hofuf outbreak.

Laboratory analysis confirmed that it was the flour which was heavily contaminated with endrin in the third Doha and the Hofuf outbreaks (Table 10). The non-specific analysis for chlorinated hydrocarbons in bread and flour from the first Doha outbreak conducted by the ARAMCO laboratory and the epidemiological data provide a sufficient basis to state that it was the flour which was contaminated with endrin in that outbreak.

Laboratory analysis confirming that endrin-contaminated flour was the cause of the second Doha outbreak is not available. However, the clinical and epidemiological picture of this outbreak strongly suggests that it was due to endrin-contaminated flour.

Davies & Lewis (1956) reported that in the endrin poisoning in Wales the time between ingestion of the contaminated bread and the onset of symptoms was about 3 hours. In 156 victims interviewed in the first Doha and the Hofuf outbreaks the median time was 2.3 hours, with a range of from about 30 minutes to 10 hours (see Table 6). These variations are probably related to dose, different food consumed with the poisoned bread, individual variation and lack of accurate recall as to the time lapse between ingestion and the beginning of symptoms.

TABLE 12
SUMMARY OF NUMBER OF VICTIMS HOSPITALIZED
AND DEATHS IN THE 4 OUTBREAKS

Outbreak	Date 1967	No. hospitalized	No. of deaths	Fatality rate (%)
First Doha	3-5 June	490	7	1.4
Second Doha	2 July	13	0	0.0
Third Doha	3-4 July	188	17	9.5
Hofuf	14-15 July	183	2	0.4
Total		874	26	3.1

In the first Doha outbreak the majority of the ill were males. This was thought to have been a reflection of the fact that this outbreak was caused by eating bread at the morning meal. It was postulated that the male adult wage-earner would be most apt to rise early, eat a hearty breakfast and thus represent the greatest proportion of those ill. However, this preponderance of males was observed again in both the third Doha and the Hofuf outbreaks. The findings of this report, taken alone, make it hazardous to conclude that males are more susceptible to endrin poisoning than females in view of the unknown sex ratio of the population exposed, the possible variation in eating patterns and the fact that different cultural habits may vary the pattern of seeking medical care when ill. Indeed, that cultural habits did affect the distribution of cases is seen from the fact that in the first Doha outbreak Qataris represented only 30% of the cases (Table 5) while in the third Doha outbreak they were represented in almost twice this proportion. This is explained by the different types of bread which served as the vehicle for the endrin, and the preference for one over the other.

Table 7 summarizes what was learned on interviewing 417 of the hospitalized victims from the four outbreaks about food items consumed prior to the outbreak. Bread was the most common item. Failure to elicit a history of eating bread by all the victims is not surprising; those who were questioned shortly after hospitalization were frequently confused so that little reliable history could be obtained, while the completeness of the stories given 1-2 days after the illness is dependent on the patients' memories, which were affected by the passage of time during which the victims had been acutely ill.

That the flour in the bread was the vehicle for the poison was readily deduced in Doha by the fact that a single brand of flour, from a single shipment, was the only common denominator in the three implicated bakeries. In Hofuf, flour was strongly suspected because only one brand had been used, and sacks of this flour were malodorous and had a liquid stain on the sack cloth.

These two brands of flour were both bagged by the same company but no other relationship could be established; the time of bagging was different, the time of shipment was different and they were shipped from two different ports on different ships to two different destinations.

That contamination of the flour took place after bagging is suggested by the stain on the sack cloth

and by the laboratory analysis of the specimens taken from the heavily contaminated sack. As shown in Table 11, there was a very high concentration of endrin in the sack cloth itself (194 000 ppm); the flour from this sack also contained a very great amount of endrin (28 070 ppm) but less than the cloth, and the concentration decreased the further into the bag the specimen of flour was taken (4460 ppm).

The source of the contaminating endrin at first posed a problem. Endrin is not known to be used or available in Qatar or Saudi Arabia. The only relationship that could be established between those two separate shipments of endrin-contaminated flour and a source of endrin was the endrin which was carried on both Ships A and B. In Ship A the flour was in a lower hold and the endrin was stowed on the tween deck of the same hold just above the flour. On Ship B flour was stowed in a lower hold above which the 5-US-gallon pails of endrin were stowed as deck cargo (Fig. 1 and 2). If the containers of endrin were leaking, as reported at the time of off-loading, this stowage arrangement provided an opportunity for the contamination of the flour to take place.

That two separate contaminations took place is the only conclusion that can be drawn from this investigation. The only common denominator found for the two shipments of endrin is that they reportedly came from the same country of origin. Attempts to demonstrate a common causative factor for the contaminations, such as faulty containers, were not conclusive.

The validity of the technique by which the health authorities in Qatar attempted to determine whether other flour was contaminated with endrin has not been established. The difficulties of carrying it out, even in the best conditions, are obvious. The findings did, however, permit the use of this flour, which was badly needed, with some assurance of safety.

The success of the other precautionary measures taken by the Governments of Qatar and Saudi Arabia, which are designed to prevent repetitions of these episodes and are described in this report, depends largely on the accuracy and completeness with which toxic chemicals and foodstuffs are labelled. Also, a ship's cargo-stowage plans and manifest sheets must carefully define all the cargo on board the ship. It is to be noted that considerable delay was caused in the Hofuf investigation

because the endrin on board the ship was identified only as "white label" in the cargo-stowage plans.

There is an obvious need for more stringent regulations and their rigorous application by producers, shippers and importers of toxic chemicals and foodstuffs, so that repetitions of the outbreaks described in this report will not occur.

THE ROLE OF WHO AND OTHER INTERNATIONAL ORGANIZATIONS

The Governments of Qatar and Saudi Arabia both requested assistance from the World Health Organization (WHO). This assistance was provided in three ways:

1. WHO sent to Qatar a consulting WHO toxicologist, a WHO sanitary engineer, and the Chief of the Health Laboratory Services unit of WHO. These persons provided expert information and advice to the Government and assisted the local health authorities in gathering information, making inspections, collecting specimens and in the adoption of preventive measures.

Later, at the time of the Hofuf outbreak, a special investigation team was provided by WHO at the request of Qatar and Saudi Arabia. This team, headed by Dr Wayland J. Hayes Jr of the National Communicable Disease Center, Atlanta, Ga., USA, assisted in completing the investigations of the four outbreaks, evaluated the findings, and made recommendations to the Governments on precautionary measures to be taken.

2. WHO, throughout the investigations, provided a central clearing house for information as it was acquired and in turn made certain that appropriate organizations were kept informed of the relevant findings. In addition, they took direct steps to gather useful information which assisted in ascertaining the cause of the outbreaks. In this, they were greatly assisted by the Medical Department of ARAMCO.

3. WHO, recognizing the potential threat to other countries from foodstuffs carried on board the two implicated ships, provided the relevant information, by cable, to health administrations in the countries in which the two ships off-loaded cargo during their voyage. As a result of this action, the World Food Program reported that 250 sacks of flour off-loaded from Ship B in Aqaba were found to be badly stained and foul-smelling. This flour was removed from the consignment and destroyed. Later, by a letter to all Member States and Associate Members of the Organization, WHO provided full information about the poisoning and pointed out the need for corrective measures.

Both during and since the outbreaks, WHO has been working in co-operation with the Inter-Governmental Maritime Consultative Organization. The latter, on the basis of information provided by WHO, promptly informed its Member States about the outbreaks. Both organizations are now working towards the goal of having regulations and practices developed and implemented that will prevent such contamination of foodstuffs by poisons during shipments.

Annex

INDIVIDUALS WHO PARTICIPATED IN THE INVESTIGATIONS

The information compiled in this report was made available by the diligent investigations conducted by many individuals. Without their efforts, critical observations and accurate reporting this compilation would not have been possible. In addition, acknowledgement is made to the organizations that provided the means and the tools for these investigations.

The following is a list of the key professional personnel who participated in the investigations:

Government of Qatar

- Dr M. Farid Ali, Director of Medical and Public Health Services, Qatar
- Dr A. Gotting, Acting Medical Officer of Health, Qatar
- Dr M. Mishali, Acting Medical Officer of Health, Qatar
- Dr A. Hakki, Chief of Medicine, Doha General Hospital, Qatar

Dr M. Reda, Chief of Paediatrics, Doha General Hospital, Qatar
 Mr M. Farah, Director of the Agricultural Department, Qatar

Government of Saudi Arabia

Dr Hashm Abdul Ghaffer, Deputy Minister of Health, Saudi Arabia
 Dr J. Ashy, Director General of Preventive Medicine, Ministry of Health, Saudi Arabia
 Dr A. Farag, Director of the Central Laboratory, Ministry of Health, Saudi Arabia
 Dr Saif ad-Din ash-Shishakli, Director of Health, Eastern Province, Saudi Arabia
 Dr Khattab, Director of the Hofuf Government Hospital, Saudi Arabia
 Mr Abd al-Aziz al-Quraishi, General Manager, Saudi Government Railroad, Saudi Arabia

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 Dr R. Oertley, District Medical Administrator
 Dr A. Gelpi, Chief of Internal Medicine
 Mr F. Myers, Operations Administrator, Preventive Medicine
 Mr F. Pretsch, Industrial Hygienist
 Mr L. Carson, Supervisor, Preventive Medicine

Mr E. Douglas, Supervisor, Environmental Health
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 Mr G. Walker, Detective Sergeant

RÉSUMÉ

Plusieurs cas d'intoxication aiguë collective due à l'absorption d'aliments contaminés par des insecticides ont déjà été signalés. Le plus grave s'est produit en 1958 à Kerala, Inde, où, sur 828 personnes empoisonnées par le parathion, l'on compta 106 décès. Le présent article décrit quatre accidents similaires survenus à Doha, Qatar, et à Hofuf, Arabie Saoudite, en juin et juillet 1967.

Le premier foyer d'intoxication est apparu à Doha le 3 juin 1967. En trois jours, 490 personnes durent être hospitalisées: elles présentaient un syndrome aigu caractérisé par des douleurs abdominales, des nausées, des vomissements, avec désorientation, perte de conscience et convulsions. Sept malades succombèrent. Le 2 juillet, 13 personnes furent admises à l'hôpital pour les mêmes symptômes. Il n'y eut aucun décès. Le 3 juillet, 188 nouveaux malades durent être hospitalisés, et l'on déplora parmi eux 17 décès. Enfin, environ 15 jours plus tard, 183 cas d'intoxication furent observés à Hofuf, provoquant 2 décès.

L'examen des premiers patients fit d'abord croire à une intoxication, d'origine hydrique, par organophosphorés, mais l'enquête démontra qu'il fallait incriminer le pain fabriqué par certaines boulangeries. L'analyse toxicologique de divers échantillons (farine, pain, sang et urine de malades, tissus prélevés à l'autopsie) montra la présence d'un insecticide organochloré, l'endrine, qui n'est utilisé ni à Doha ni à Hofuf. On devait finalement découvrir l'origine de la contamination de la farine à bord des deux navires qui l'avaient amenée dans ces deux villes. La cargaison de ces bâtiments comportait en effet un chargement d'endrine, entreposé au-dessus des sacs de farine. Certains des récipients d'insecticide, en mauvais état, avaient laissé échapper leur contenu.

Des mesures ont aussitôt été prises par les autorités locales: saisie et destruction des stocks de farine contaminés, mise sur pied d'un système d'inspection des navires transportant des denrées alimentaires.

L'aide de l'OMS s'est matérialisée sous trois formes: envoi sur place d'une équipe de conseillers; organisation d'un centre chargé de recueillir et de diffuser les informations; mise en garde immédiate adressée aux pays où les deux navires avaient déchargé une partie de leur cargaison. Ultérieurement, un rapport complet sur les événements soulignant la nécessité de mettre tout en œuvre pour empêcher le retour de semblables faits a été

présenté aux Etats Membres et aux Membres associés de l'OMS.

Durant ces événements, l'OMS s'est assuré la collaboration de l'Organisation intergouvernementale consultative de la navigation maritime (IMCO). Actuellement, les deux organisations travaillent conjointement à l'élaboration de règlements destinés à éviter la contamination des denrées alimentaires au cours des transports par mer.

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